

NAVAIR Finds Alternatives for Petroleum-Based Solvents

Low-VOC, HAP-Free Solvents Meet New Environmental Regulations

ENGINEERS FROM THE Naval Air Systems Command (NAVAIR) have identified three non-aqueous, low-Volatile Organic Compounds (VOC) and Hazardous Air Pollutant (HAP)-free solvents as alternatives to CID A-A-59601 (formerly P-D-680)/MIL-PRF-680 solvents to meet new environmental regulations.

To obtain a high degree of cleanliness without corrosion, petroleum-based solvents such as CID A-A-59601

MIL-PRF-680 B contains the same amount of VOC as CID A-A-59601 but without the HAPs. CID A-A-59601 solvent, commonly called Stoddard Solvent or mineral spirits, is a widely-used, man-made organic solvent that comes from the refining of crude oil. Cold solvent cleaning of aircraft components is performed at Organizational-, Intermediate- and Depot-levels and usually takes place in either spray sinks or batch loaded dip tanks.

Under Title III of the 1990 Clean Air Act amendments, the U.S. Environmental Protection Agency (EPA) established emissions standards for categories and sub-categories of sources that emit or have the potential to emit listed HAPs. In addition, Air Pollution Control Districts in California implement the most stringent requirements, usually stated in terms of VOC content, such as the South Coast Air Quality Management District (SCAQMD) Rule 1171.

Since MIL-PRF-680 B and CID A-A-59601 are the only materials authorized by the applicable maintenance manuals to clean engine parts, an approved alternative is necessary to meet the new environmental regulations.

(P-D-680, a dry cleaning and degreasing solvent) and MIL-PRF-680 (a degreasing solvent) are used for cleaning aerospace platforms and other related equipment. P-D-680 contains HAPs and VOCs, which cause health and environmental problems. VOCs are released during cleaning operations, contributing to the formation of ground-level ozone (photochemical smog), which can damage lung tissue, cause respiratory illness and damage vegetation.

Historically, the primary solvent used for these applications has been MIL-PRF-680 B Type II, which has a VOC content of more than 750 grams per liter (g/L). Alternative processes, used to eliminate the VOC emission, are immersion cleaning with cold or hot water-based products, heated high-pressure spray washing using water-based products and exempt solvent cleaning. Water-based processes are often ineffective on heavy soils and can result in flash rusting of steel components.

The SCAQMD has imposed restrictions limiting the VOC content in solvents to 25 g/L for immersion cleaning processes or limiting equipment to airtight cleaning systems. This ruling impacts multiple naval aviation cleaning operations. Under the new rule, neither MIL-PRF-680 B nor CID A-A-59601 will be allowed in solvent degreasing operations in the SCAQMD. Since MIL-PRF-680 B and CID A-A-59601 are the only materials

authorized by the applicable maintenance manuals to clean engine parts, an approved alternative is necessary to meet the new environmental regulations.

In order to identify a solvent that meets the new regulations, NAVAIR's Materials Engineering Division at Patuxent River, MD, recently tested several candidate commercial products. While the product testing was ongoing, a new specification MIL-PRF-32295 entitled "Cleaner, Non-Aqueous, Low-VOC, HAP-Free" was developed to address environmental regulations that prohibit the use of MIL-PRF-680 B and CID A-A-59601. Because exempt VOC and non-exempt VOC cleaners exist, the specification was first developed to qualify non-exempt VOC types of cleaners. Since the Aerospace National Emission Standards for Hazardous Air Pollutants (NESHAP) states that immersion-cleaning solvents must have vapor pressures less than seven millimeters of mercury (mm Hg), and wipe cleaning solvents must have vapor pressures less than 45 mm Hg, these limits were used as the Type I and Type II classifications in the specification. The cleaning effectiveness of the candidates tested led NAVAIR engineers to further describe Type I products as suitable for cleaning light soils such as oils and hydraulic fluids and Type II products as suitable for cleaning heavy soils such as greases and carbon residues. The new specification requires that a solvent must:

- Be free of HAPs,
- Contain no more than 25 g/L of VOCs,
- Be effective on grease and oil,
- Not contain ozone-depleting substances (ODS),
- Be non-toxic,
- Be compatible with metals and non-metals, and
- Be safe to use.

The acceptance criteria for selecting alternative solvents include the following properties:

- Low-VOC (less than 25 g/L) or exempt solvent
- HAP-free
- Effective (cleaning efficiency equivalent to MIL-PRF-680 cleaner)
- Non-ODS
- High Flash Point greater than 140 degrees Fahrenheit

- Non-Corrosive
- Compatible with metals and non-metals
- Non-toxic
- Non-offensive odor
- Cost effective
- Recyclable
- Fast drying

Currently, the three solvent products listed below have met the qualification requirements of MIL-PRF-32295 Type I. These products have vapor pressures as low as one mm Hg and zero VOC contents; therefore, they meet the most stringent environmental regulations. Presently, MIL-PRF-32295 is under revision to include an exempt class of solvents.

MIL-PRF-32295 TYPE I SOLVENTS

| Product | Manufacturer |
|------------|--|
| QSOL 300 | SafetyKleen Baltimore, MD 21230 |
| Cyclo 147F | Clearco Products Bensalem, PA 19020 |
| SB32 | Fluid Momentive Friendly, WV 26146 |

National Stock Numbers have been assigned to these products as follows:

- 1 Gallon: 6850-01-576-2676
- 5 Gallon: 6850-01-576-2765
- 55 Gallon: 6850-01-576-2736

The Type I products are estimated to address a significant amount of the parts cleaned by CID A-A-59601/MIL-PRF-680 solvents at NAVAIR and Marine Corps facilities. No new candidates tested to date have met all the requirements for Type II. As a result, efforts are underway at Patuxent River to develop a new cleaner to meet the Type II requirements. In addition, MIL-PRF-32295 is under revision to include an exempt class of solvents. Because the three products above are also considered exempt from the current environmental rules, they will be re-qualified to the new class once the revision is complete.

To validate the effectiveness of the tested products in work environments (Cyclo 147F, QSOL 300 and SB32), field-

FIELD TEST SITES

| Site | Shop | Soil | Part | Solvent | Contact |
|--|------------------------------------|------------------------------|-----------------------------|------------------------|--------------------------------|
| Fleet Readiness Center East, Cherry Point, NC | Hydraulic, Engine | Oil, Hydraulic, Light Grease | Blade Shock, Roller Bearing | Cyclo- 147F | Megan Goold |
| Fleet Readiness Center Southeast, Jacksonville, FL | Engine, Wheels | Oil, Hydraulic, Light Grease | P3 Torque Wheels | Cyclo- 147F | Luzmarie Guzman-Santiago |
| Fleet Readiness Center West, Naval Air Station North Island, San Diego, CA | H-60 Integrated Maintenance Center | Oil, Hydraulic, Light Grease | Floor Board Rollers | Cyclo- 147F, QSOL- 300 | Luc Doan |
| Camp Pendleton, CA | Armory | Dust, Dirt, Carbon | Weapon Parts | QSOL -300 | Josh Brody |
| Coast Guard, Elizabeth City, NC | Transmission | Oil, Hydraulic | Gearbox, Shaft, Parts | QSOL- 300 | Mike Hanson |
| Andrews Air Force Base, MD | Bearing | Grease | Roller Bearing | SB-32 | Michael Megyesy |
| Naval Station, Norfolk, VA | Wheels Patch Test | Light Grease Hydraulic | Wheels Hydraulic System | SB-32 | Nathan Richard, Jeff Edlund |

testing was conducted on different weapon systems at several Navy, Air Force, Marine Corps and U.S. Coast Guard sites over the past several months. Each cleaning solvent was tested side-by-side with the current MIL-PRF-680 Type II solvent, cleaning identical parts for the duration of the test. Cleaning techniques such as brush, immersion and wipe cleaning were utilized based on the specified method of cleaning applications.

Photographs of the parts were taken before and after cleaning to compare the effectiveness of the tested cleaners to the control.

At each testing site, one cleaner was used in cleaning certain parts at one of the maintenance shops such as hydraulic, engine, wheels and bearing shops. The field test evaluation criteria were based on the type of platform, cleaning effectiveness, the photographs before and after the cleaning, compati-

bility with metals and non-metals, type of soil, drying time, residue, odor and squadron recommendations. The reports received from all testing sites showed successful results with positive feedback (“good” comments) from all users of the new products.

This effort was initiated to identify alternative replacement for CID A-A-

59601/MIL-PRF-680 solvents to meet the new environmental regulations. As a result of this effort, a new specification for low-VOC cleaners was developed and issued, which can be used at locations where environmental regulations prohibit the use of CID A-A-59601 and/or MIL-PRF-680 B. Three cleaners were qualified to the new specification, and field-tested in relevant operating environments. It is anticipated that users in naval aviation, other Department of Defense facilities, and the U.S. Coast Guard will benefit from this new specification as environmental regulations continue to tighten.

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All photos by Megan Goold

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Before Cyclo 147F solvent.



After Cyclo 147F solvent.



Before MIL-PRF-680 solvent.



After MIL-PRF-680 solvent.